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ORIGINAL ARTICLE

Development of surgical phalloplasty techniques: Is there a gold standard? ☆

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Summary

Introduction. — In the field of penile reconstruction surgery there is a range of techniques, including fasciocutaneous, septocutaneous, myocutaneous, osteocutaneous and osteomyocutaneous flaps, taken from the suprapubic, abdominal, inguinal, scapular, deltoid, thoracodorsal, fibular or anterolateral thigh areas or from the forearm or arm. Among this wide variety of techniques, is there a gold standard treatment to identify best practice, and what are the criteria that should be used to define such a standard? The aim of this article is to provide an overview of the main phalloplasty techniques and to show their advantages and drawbacks, in order to answer the ultimate question, of whether a gold standard can be identified or not.

Method. — Literature review using Pubmed and selection of articles about the most common types of phalloplasty, and how these have changed over time. Selection of articles that evaluate the main techniques.

Results. — Six phalloplasty techniques (flaps from the suprapubic, abdominal, inguinal, forearm, fibular and anterolateral thigh areas) are described. There have been few studies that formally evaluate these techniques, other than studies of complications, even though it is suggested that some techniques preserve erogenous sensitivity.

Discussion. — The criteria that an ideal phalloplasty must fulfil are: 1) satisfactory aesthetic appearance; 2) creation of a neourethra which enables urination while standing up; 3) sufficient rigidity to have sexual relations; 4) tactile and erotic sensitivity; 5) surgery carried out in just one stage; 6) low levels of donor site morbidity and site must be easy to hide; 6) density, texture and colour to match the perineum. No technique currently meets all these criteria and thus no

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gold standard treatment can easily be identified. Any standard, if one is to exist, must stress the need to inform and educate patients in order that their needs be met and in order to reduce unrealistic expectations and postoperative disappointment.

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Since the first phalloplasty, which was carried out in 1936 by Borgoras using a pubic rotation flap, several phalloplasty techniques have been developed. Free flaps soon followed, and a range of phalloplasty interventions is now available, from fasciocutaneous, septocutaneous and myocutaneous flaps that provide varying degrees of density to the neophallus, to osteocutaneous or osteomyocutaneous flaps that provide a level of rigidity. Tissue may be taken from the suprapubic, abdominal or inguinal regions to provide rotational flaps (Bettocchi et al., 2005; Davies and Matti, 1988; Küntscher et al., 2006; Puckett et al., 1982; Sun and Huang, 1985); or from the forearm, arm, scapular, deltoid, thoracodorsal, fibular or anterolateral thigh regions to provide free flaps (Chang and Hwang, 1984; Dabernig et al., 2006; Fang et al., 1994; Felici and Felici, 2006; Gilbert et al., 1987; Gottlieb and Levine, 1993; Hage and De Graaf, 1993; 1993c; 1996; Hamilton and Morrison, 1982; Harashima et al., 1990; Kimata et al., 1998; Kimura et al., 2001; Meyer et al., 1986; Monstrey et al., 2005; Muta, 2000; Rubino et al., 2009; Sadove et al., 1993; Santanelli and Scuderi, 2000; Song et al., 1982, 1984; Wang et al., 2007; Wei et al., 2002). Each technique offers its own advantages and drawbacks, but is there one technique that could be identified as a gold standard in phalloplasty?

The gold standard in phalloplasty

In 1987, Gilbert et al. published the first literature review and suggested criteria that an optimum phalloplasty should meet. These criteria, which have been used by all authors since then (Bettocchi et al., 2005; Capelouto et al., 1997; Dabernig et al., 2006; Fang et al., 1999; Felici and Felici, 2006; Gilbert et al., 1987; Hage et al., 1993a; Hage and De Graaf, 1993; Hage et al., 1993c; Hage et al., 1996; Kim et al., 2007; Papadopoulos et al., 2002), are:

- 1) satisfactory appearance;
- 2) creation of a neourethra which enables urination while standing up;
- 3) sufficient rigidity;
- 4) tactile and erotic sensitivity;
- 5) surgery carried out in just one stage;
- 6) low levels of donor site morbidity and site must be easy to hide.

The ideal goal is undoubtedly an aesthetically satisfactory and functional penis, but techniques that meet all these criteria are scarce (Monstrey et al., 2005). There is a level of consensus to support the forearm flap, but no technique seems to meet all needs. There are still two major obstacles: urethroplasty and disfigurement at the donor site.

Changes in rotation flaps (and transposition flaps)

The first phalloplasty is attributed to **Bogoras (1936)** after the first world war, in order to treat amputation of the penis (Edgerton et al., 1970; Kim et al., 2007). It was based on a tubular pubic flap, made rigid by costal cartilage, and did not contain a urethra (Edgerton et al., 1970). The first creation of a neourethra is attributed to **Gillies and Harrison (1948)** who made the first pedicle in the form of a "tube within a tube" (neourethra within a neophallus) and this technique was to become standard, and is still used today. **Orticochea (1972)** is credited with creating the first transposition flap using a subcutaneous tunnel, in which a myocutaneous flap using the gracilis muscle in the thigh (Fig. 1) was transposed into the pubic region.

Inguinal flap

Transposition techniques meant that **Puckett et al. (1982)** were able to attempt the first inguinal flap, and this was soon repeated by **Sun and Huang (1985)**. The pedicle included the circumflex iliac artery and both its branches. The authors constructed the urethra using the skin from the scrotal septum, which was anastomosed directly to the native urethra.

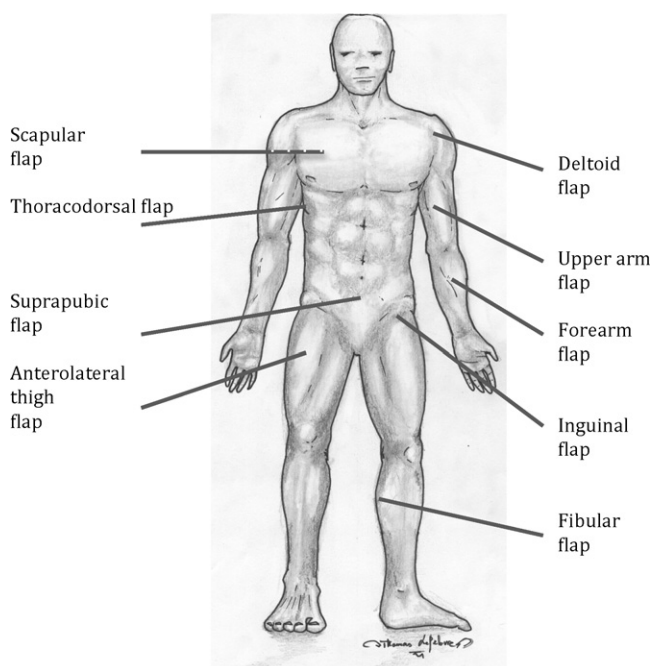


Figure 1 Locations of flaps (donor sites) used in various types of phalloplasty.

A subcutaneous tunnel was created, from the donor site to the pubic symphysis, and the flap was transferred.

Abdominal and suprapubic flaps

Adapting the technique used by [Bettocchi et al. \(2005\)](#), [Pryor and Gill \(1991\)](#) created a suprapubic phalloplasty using the clitoris, incorporating as far as possible the superficial external pudendal vessels. The neourethra was constructed using the skin from one of the labia majora, which was tubed around a catheter and inserted into the pubic flap, which itself had been tubed. This was anastomosed to the native urethra, in a second stage. The clitoris is sometimes incorporated, in order to provide better erotic sensitivity. The procedure, according to the authors, is simple, but urethroplasty is still problematic.

One of the authors of the present article (NMJ) has adapted the suprapubic technique in order to produce a more extensive abdominal phalloplasty that is based on expansion balloons. The neophallus is constructed using tubularisation of the distended abdominal skin, the upper portion of which is detached in a subsequent stage ([Leriche et al., 2008](#); [Morel-Journel et al., 2011](#)). Urethroplasty remains problematic, and this flap does not contain a urethra. It is offered to patients who want surgery without excessive visibility of the donor area. Final abdominoplasty to the distended tissue can leave a slight trace at the scarred area.

Free flaps

Forearm flap or Chinese flap

The first forearm flap was created by [Chang and Hwang \(1984\)](#) who formed it from a tube-within-a-tube using the Gillies formula. This type of flap has become the standard, which is still used today. [Meyer et al. \(1986\)](#) attempted the first adaptation of this technique, by lengthening the native urethra using a vaginal flap. [Bouman \(1987\)](#) attempted a similar technique using the labia minora to minimise stenosis at the junction. The flap incorporates part of the ulna, tubed around a catheter and covered with a tubed radial section in order to create the neophallus ([Meyer et al., 1986](#)). The pedicle (technique used by authors NMJ and PB) includes the radial artery, which is anastomosed to the inferior epigastric artery (NMJ) or the femoral artery (PB) and the basilic and cephalic veins to the saphenous complex. The branches of the median cutaneous nerves are coapted to the ilioinguinal and iliohypogastric nerves, and the lateral nerve of the forearm to one (NMJ) or two (PB) clitoral nerves.

Fibular flap

In an effort to find donor sites that would enable any scarring to be hidden, [Sadove et al. \(1993\)](#) attempted the first fibular flap (osteocutaneous) and carried out urethroplasty in situ prior to phalloplasty. [Dabernig et al. \(2006\)](#) adapted this technique to use no bone, to reduce morbidity at the donor site (fracture, walking difficulties, use of splints). Although it is not often used, the authors stress the advantages of this type of flap, as the donor site can be hidden under trousers.

Anterolateral thigh flap

Developments in perforator flaps have led to the anterolateral thigh flap ([Kimata et al., 1998](#); [Kimura et al., 2001](#); [Mutaf, 2000](#); [Wei et al., 2002](#)), which can be seen as an island flap for transposition or as a free flap ([Rubino et al., 2009](#)). Island flaps were first suggested by [Santanelli and Scuderi \(2000\)](#) for patients who refuse a forearm flap for aesthetic reasons. The island flap incorporates the lateral circumflex femoral artery, the associated veins and the cutaneous femoral nerve, which can be preserved during transfer using a subcutaneous tunnel or coapted to a clitoral nerve in order to preserve erotic sensation.

[Felici and Felici \(2006\)](#), like [Dabernig et al. \(2006\)](#), mention the poor rates of acceptance of forearm phalloplasty, which is described as a "brand" that marks out these patients' identity concerns. The flap that is taken between the rectus femoris and vastus lateralis muscles incorporates the perforator vessel coming from the rectus femoris and the septal or muscular perforator vessels. The descending branch of the lateral circumflex femoral artery is anastomosed to the femoral and genicular artery, and the lateral cutaneous femoral nerve is coapted to the ileopubic nerve. Urethroplasty is carried out using a peri-clitorideal flap, which is inserted into the femoral flap and anastomosed to the native urethra 6 months later. [Descamps et al. \(2009\)](#) use a similar technique involving the perforator vessels of the rectus femoris and sartorius muscles and transpose the flap to the perineal region using a subcutaneous tunnel.

Evaluation of techniques

Even though there is such a wide variety of techniques and adaptations of techniques, there have been few studies that assess the consequences of phalloplasty. Most articles describe techniques, each of which was used on a limited number of patients, who in some cases were not transsexual. The appearance of phalloplasty outcomes is often described as satisfactory, but the photographs are disappointing (e.g. lateral curvature, disproportionate size, striking areas of scarring). In the hundreds of articles that have been written, perineal sensitivity is only evaluated in a few, although several authors claim that erotic sensitivity was preserved. It is often suggested that a clitoral nerve should be preserved in order to maintain erotic sensitivity, but it is also suggested that the clitoris be included in the flap, for similar reasons. Sexuality remains largely unstudied, apart from ability to orgasm.

[Dubin et al. \(1979\)](#), carried out the first literature review on abdominal phalloplasty, and included their own results, which involved 48 patients. They described a complication rate of 58% and a satisfaction rate of 45%, but they give no details of the tools used to measure this. [Gilbert et al. \(1987\)](#) evaluated complications associated with 15 phalloplasties (three of which involved transsexual patients). A year later, [Gilbert et al. \(1988\)](#) assessed for the first time perineal sensitivity of seven forearm phalloplasties and found good sensation on the glans penis, but not on the posterior aspect of the neophallus. [Hage et al. \(1993a\)](#) sent 200 questionnaires (150 were returned) and showed that the point of view of patients can be different from that of the surgeon. The

patients' preference was for abdominal phalloplasty over forearm, while the surgeons claimed the opposite. These data are in line with our results, which compare the two techniques directly (Courtois et al., 2011; Morel-Journal et al., 2011).

Fang et al. (1999) offered an excellent discussion on the complications associated with forearm free flap phalloplasty as they reviewed the literature and added 22 of their patients assessed with tactile and erogenous sensitivity. Selvaggi et al. (2007) assessed tactile and vibratory sensation on the neophallus of 105 patients with forearm free flap phalloplasty and concluded that tactile sensitivity was improved by coapting the donor site nerve with only one clitoral nerve, but that preservation of the clitoris underneath the neophallus was necessary in order to maintain orgasm capacity.

Cheng et al. (1995) carried out the first direct comparisons between several techniques, and provide an excellent discussion about the advantages and limitations of each technique (forearm, abdominal, and anterolateral thigh flaps) in a study that involved 136 patients (14 of whom were transsexual). Schaff and Papadopoulos (2009) compared forearm phalloplasty (six patients) with fibular phalloplasty (31 patients) and showed that fibular flap is preferable in terms of quality of sexual relations afterwards, but that greater sensitivity and satisfaction were achieved with the forearm flap. Monstrey et al. (2005) provide an excellent discussion of their experience in forearm phalloplasty involving 81 transsexual patients, but they do not describe the tools they used to measure outcomes. They conclude that forearm phalloplasty is superior, but offer no direct comparison with other techniques. Leriche et al. (2008) evaluated 58 retrospective records of forearm phalloplasty and answers to a questionnaire (53 respondents) about satisfaction with postoperative and sexual outcomes. Appearance was said to be satisfactory in 90% of cases, and sexual relations in 51% of cases, and although tactile sensitivity is mentioned by 83% of patients, only 9% mention erogenous sensitivity. Bettocchi et al. (2005) present a realistic (and sobering) picture of complications, particularly those that involve the urethra (up to 94% of patients experienced complications). They stress the importance of providing psychiatric evaluation for patients and of informing and educating them of the advantages and limitations of the various techniques, in order to avoid unrealistic expectations and postoperative disappointment.

Conclusion

Despite the many different techniques and adaptations that have been developed in order to improve phalloplasty, the choice of one technique over another is still very much a matter for individual experts. There have been few scientific evaluations, apart from those involving complication rates, and there have been few comparisons of different techniques. Although criteria have been stated, that should be met by an optimal phalloplasty, no technique currently meets all the criteria (Monstrey et al., 2005; Morel-Journal et al., 2005). There seems to be no gold standard, and several techniques currently coexist, that can respond to patients' differing needs and expectations. Rather than find-

ing a gold standard, the standard approach ought to be to educate and inform patients in order to reduce unrealistic expectations and in order to limit disappointment (Bettocchi et al., 2005).

Disclosure of interest

The authors declare that they have no conflicts of interest concerning this article.

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